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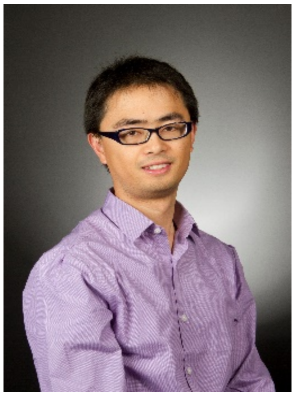

Thermal Energy Conversion and Heat Control with Nanoscale Radiative Transfer

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Dr. Liping Wang received his Ph.D. in mechanical engineering with a focus on nanoscale radiative heat transfer in 2011 at Georgia Institute of Technology under the guidance of Professor Zhuomin Zhang. He started his academic career as an assistant professor at Arizona State University in 2012 and was promoted to associate professor with tenure in 2018. Dr. Wang's research aims to selectively control thermal radiation for energy applications by fundamentally understanding and exploring novel physical mechanisms in nanoscale radiative transport. Besides, he has been investigating near-field thermal radiation for energy harvesting and thermal management applications, in addition to the development of many novel optical and thermal metrologies. His research findings have been published in more than 60 peer-reviewed high-impact journal papers in applied physics, optics, heat transfer, and materials. Dr. Wang has been serving as Secretary for ASME K9 Nanoscale Thermal Transport Committee since 2018, and organizing many international heat transfer conferences. He is the recipient of *2017 AFOSR Young Investigator Award, 2016 JQSRT/Elsevier Viskanta Young Scientist Award,* and *2015 NSF CAREER* Award, as well as *2013 Top 5% ASU Engineering Faculty Teaching Award*.

Spectral control of thermal emission or absorption plays a crucial role in efficient thermal energy harvesting and radiative cooling, while near-field effect between objects within subwavelength vacuum distances could greatly enhance radiative heat transfer beyond blackbody limit for augmented heat flux and power density. In this talk, I will mainly discuss our recent experimental progresses in highly-efficient solar thermal energy conversion, dynamic radiative thermal control, and super-Planckian near-field radiative heat transfer. In particular, nanostructured metamaterial selective absorbers were fabricated and temperature-dependent optical and infrared radiative properties were characterized. Large-area metafilm absorber with excellent spectral selectivity and high-temperature stability was experimentally demonstrated to enhance solar-to-heat conversion at multiple suns, while its impact on solar thermophotovoltaic conversion was theoretically predicted. For dynamic radiative thermal control, thermochromic VO_2 based metafilm structure was developed, whose infrared emissivity increases significantly for enhanced radiative cooling when it is above phase transition temperature. A vacuum thermal measurement was performed to demonstrate how the tunable VO_2 metafilm modulates radiative heat flux with temperature. On the other hand, a tunable metamaterial with patterned Al gratings on VO_2 thin film exhibits an opposite behavior with lower infrared emissivity when VO_2 is metallic at high temperatures, indicating thermal runaway. To experimentally demonstrate near-field thermal radiation, we used polystyrene nanoparticles as spacers between two 5×5 mm^2 Al-coated silicon chips to achieve vacuum gap of 215 nm, at which radiative heat flux between nanometric Al films was measured to be 7.4 times over blackbody limit or by 480 times compared to far-field radiative heat transfer between metallic surfaces. In another work, SU8 polymer microposts with different heights were fabricated to directly create nanometric vacuum gaps which were precisely determined by in-situ capacitance measurements. The near-field thermal radiation between two 1×1 cm^2 heavily-doped silicon chips was measured to be 11 times over the blackbody limit at 190 nm gap. Finally, designs of near-field thermal rectifier, thermal switch and thermal modulator will be proposed, and future near-field experiments will be briefly described.

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